

**IMPROVING COGNITIVE INDEPENDENCE OF
DEMENTIA PATIENTS USING MACHINE LEARNING
ENABLED MOBILE
APPLICATION**

Project Id: 2023-081

Jayasinghe J.M.S.U.

IT20034740

B.Sc. (Hons) Degree in Information Technology
(Specialization in Software Engineering)

Department of Computer Science and Software Engineering

Sri Lanka Institute of Information Technology

Sri Lanka

September 2023

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The dissertation was submitted in partial fulfilment of the requirements
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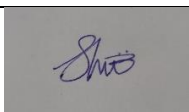
Sri Lanka Institute of Information Technology

Sri Lanka

September 2023

DECLARATION

I declare that this is my own work, and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Jayasinghe J.M.S.U.	IT20034740	

The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor

Date

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ABSTRACT

In general, dementia is defined as a memory, thinking, or decision-making impairment that interferes with daily tasks. Researchers say, personal journal keeping can reduce the risk of dementia in all causes. Simply, a personal journal is a diary that a person keeps for the purpose of logging their everyday emotions, thoughts, and sentiments. Dementia patients can reduce the severity of the condition of the disease by maintaining a diary day by day. Diary keeping helps in storing the data and information associated with the patients' experiences as well. Here, we consider dementia patients at mild and moderate stages of the disease. The information in web results that more elderly persons are at risk when comparing the ages of the affected. As most of the patients are old, their articulacy and literacy may be poor. Therefore, the suggested solution is an innovative diary keeping technique, which is a digital audio diary where patients can record voice and keep tracks saved in their mobile inside an application. Further these voice recordings are converted into texts and saved for later observations as well. Finally, a summarized deliverables could be obtained by examining the speech and text files. Machine learning along with natural language processing mechanisms are used in so-called implementations. With the use of this solution, we hope to improve the quality of life of mild to moderate dementia patients.

Keywords – Dementia, Voice recognition, speech to text, natural language processing

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LIST OF ABBREVIATIONS

Abbreviation	Description
LPC	Linear Predictive Coding
MFCC	Mel-frequency cestrum co-efficient
HMM	Hidden Markov Model
ASR	Automatic Speech Recognition
ANN	Artificial Neural Networks
NLP	Natural Language Processing
BART	Bidirectional and Auto-Regressive Transformers

1. INTRODUCTION

1.1. Background & Literature Survey

In this comprehensive study, our primary focus delved into the extensive body of technological advancements related to dementia patients, highlighting a significant connection with the indispensable role of caregivers in their care. Recognizing the paramount importance of fostering patient independence, our proposed solutions predominantly centered around enhancing the individual experience of the patient. This approach is pivotal given the alarming global prevalence of dementia; a pressing issue that sees a new case diagnosed approximately every three seconds on a worldwide scale. As we fast-forward to 2020, the statistics paint a dire picture, with the number of individuals grappling with dementia surpassing a staggering 55 million. Shockingly, projections indicate an even more distressing trajectory, with estimates reaching a formidable 78 million by 2030 and an astonishing 139 million by 2050. It is essential to underscore that this exponential surge will be most pronounced in developing nations, accentuating the urgency of our research [1].

When delving into the demographics of mild to moderate dementia, we uncover a spectrum of ages impacted by this debilitating condition. While it remains a rarity, dementia can afflict individuals as young as 30, though such cases are outliers. The predominant demographic of younger dementia sufferers falls within the middle-aged bracket, typically between 50 and 60 years old. These individuals, diagnosed with dementia before the age of 65, are often classified as having "young onset dementia," "early onset dementia," or "working life dementia," underscoring the diverse range of ages and life stages affected by this challenging condition [2].

The findings from a series of earlier studies conducted by researchers Jessica J. Weyerman, Cassidy Rose, and Maria C. Norton have cast a spotlight on the profound impact of journal writing on dementia risk. In their expansive research, encompassing a

substantial cohort, a remarkable revelation emerged: individuals who had engaged in the practice of journaling experienced a striking 53% reduction in their risk of developing dementia, irrespective of its underlying causes. These profound results serve as a powerful testament to the potential protective effects of this simple yet transformative habit.

Furthermore, when we examine the investigation's finer points, we find an even more complex web of correlations. A significant predictor of both Alzheimer's disease (AD) and dementia risk from all sources found in a sample of participants' transcribed works: the presence of terms with six or more letters. These associations were discovered using comprehensive logistic regression models that carefully accounted for influencing variables like age, educational attainment, gender, and Latter-Day Saint affiliation. Such thorough investigation not only strengthens the validity of these conclusions but also highlights the complex relationship between journaling and cognitive health [3].

This body of research, which is supported by empirical data, not only presents a convincing case for the potential preventative advantages of journal keeping in reducing the incidence of dementia but also calls for more investigation into the complex mechanisms underlying this occurrence. It is clear from considering the implications of these findings that encouraging the habit of journaling may be essential for preserving cognitive health in an older population.

Some researches mentioned a diary interview technique that has been used to investigate daily patterns of a dementia patient. As mentioned in the research paper, the requested diary interview method, in which a participant records his or her thoughts and feelings under the guidance of a researcher, has been used in health research since the 1930s (Burman, 1995). It has been modified to examine the lives of people with dementia. When people are asked to keep a regular journal of their experiences, rich data about individual motivations, emotions, and beliefs are collected in an unobtrusive manner over time [4]. The progress shows that patients were able to understand the days separately and some said they enjoyed keeping the diary records as well.

The "Dementia Diaries" project left an indelible mark on both diarists and their partners, as revealed in an independent evaluation. This initiative not only provided a platform for

documenting experiences but also instilled a profound sense of purpose and focus. For diarists, crafting entries became a worthwhile endeavor, offering them a clear goal to pursue amid the challenges of dementia. Most strikingly, this project empowered individuals by making them feel valuable and valued. Knowing that their entries were being read and benefiting others filled them with a profound sense of worth. "Dementia Diaries" transcended mere documentation; it became a source of validation, connection, and hope, highlighting the transformative potential of storytelling and shared experiences in the context of dementia care [5].

An online survey was also conducted for more data gathering and research purposes and more than 50 responses were collected.

Do you think a personal journal would help dementia patients to stabilize their memory?
64 responses

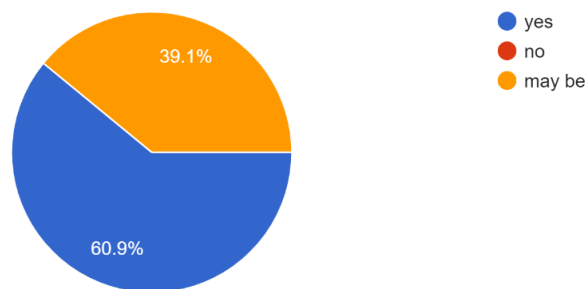


Figure 1.1. 1 survey results on journal impact to stabilize memory

The survey's findings suggest a link between keeping a personal journal and dementia patients' ability to stabilize their memory. When asked if keeping a personal diary helps maintain memory, the majority of respondents, 60%, said "yes," while 40% said "no." This implies that a sizable proportion of people have reported memory stabilization as a result of keeping a personal diary. Personal journals can serve as a record of everyday

activities, thoughts, and feelings, which can aid memory and knowledge retention in dementia sufferers. Additionally, keeping a diary may help to lessen stress and anxiety, which can improve general cognitive function.

What kind of a diary will you recommend ?
64 responses

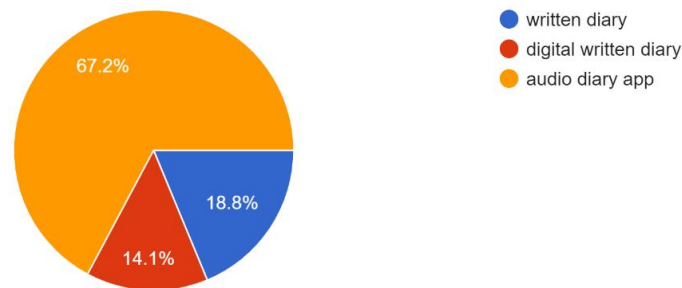


Figure 1.1. 2 survey results on diary type

The results obtained were more favorable with proposed system and the audience responded with positive reflections. According to the study findings, 67.2% of participants would rather keep an audio diary than a written one or a digital one. Only 18.8% of respondents said they preferred a written diary, and 14.1% said they preferred a digital diary. These results imply that many people who want to keep a private journal of their thoughts and experiences select audio diary keeping as their preferred technique.

The ease with which people can naturally and spontaneously record their thoughts and feelings makes audio diaries popular, perhaps for this reason. Audio diaries can be easily and rapidly recorded using a smartphone or other recording device, in contrast to written journals, which demand time and effort to physically transcribe material. Additionally, audio diaries might be easier for people to access who struggle with reading and writing or who might have trouble using technology. It is important to keep in mind that keeping an audio journal may have some disadvantages. For instance, organizing and searching

through recordings could be more challenging than written or digital written information. Additionally, audio recordings may be prone to loss or damage, which could lead to the loss of important data.

Overall, the survey's findings indicate that people who want to keep a private journal of their experiences, ideas, and feelings frequently choose to keep audio diaries. Before selecting a strategy to use, people should take into account the potential advantages and disadvantages of various diary-keeping techniques.

1.2. Research Gap

According to the literature survey, most of the diaries are maintained to collect data and caregivers were responsible in a way during the process. But the outcome of this system is to improve the independency of the dementia patient. Therefore, patient-friendly techniques are used in the proposed system. The main benefit is that this is an audio diary. It helps the elderly patients. They can access the diary even without any help from the others. An audio diary is easy to handle than a written diary because the literacy levels are much lower among the dementia patients.

However, there are enough evidence to say that this diary keeping technique is beneficial to a dementia patient. Some related work say that patients even enjoyed diary writing as well [4]. When their life patterns are recorded in a daily basis, they get familiarized with the daily routine and this leads in improvement in their memory. Therefore, the condition of the illness can be reduced or kept not being severely affected.

When comparing the data collected and proposed deliverables, there are no existing system or a single application that includes all the functionalities given in the following table.

Table 1: Research gap

	[3]	[4]	[5]	Proposed system
Including audio recordings of patients	no	yes	yes	yes
Usage of voice recognition	no	yes	yes	yes
Speech to text conversion and storage of text files	no	no	no	yes
Calendar based diary to access daily diary records	no	no	no	yes
Text summarization	no	no	no	yes

This research component of the proposed system includes all of the above-mentioned features. Since there are no any application with all the features the proposed system to be implemented is a novel innovative creation.

The online survey responses are shown below.

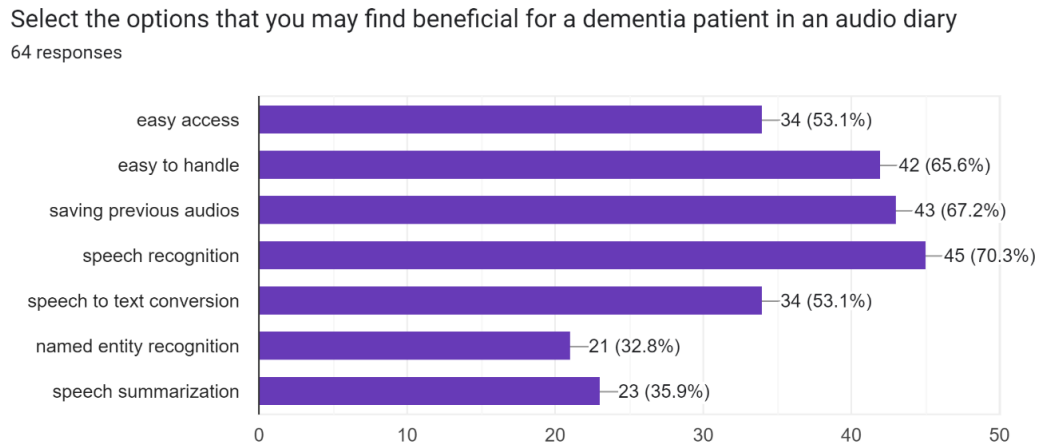


Figure 1.2. 1 survey results on benefits

According to the survey's findings, users greatly valued capabilities like speech recognition, speech-to-text conversion, storing older audio recordings, and simple access. This implies that those wishing to adopt audio diary keeping or other comparable technologies should take these advantages into account. For those who struggle with writing or typing, speech recognition and speech-to-text conversion can be helpful features that make it simple and quick for them to capture their ideas and experiences. These capabilities also make it convenient to record data hands-free, which may be especially helpful for people with limited mobility or who are always on the move. People may keep their recordings organized and accessible by saving older audio files and using features that make it easy to access them. Easy access features can make it simple to record fresh material or to examine past recordings at any time, and being able to rapidly search through previous recordings can help people discover the information they're looking for.

Overall, the survey findings indicate that when it comes to audio diary keeping or other similar tools, people favor features that provide organization, accessibility, and ease. Speech recognition, speech-to-text translation, preserving previously recorded audio files, and quick access features can all contribute to making audio diary keeping a useful tool for anyone who want to keep a journal of their ideas and experiences.

1.3. Research Problem

The main significant feature of a dementia patient is the occurrence of memory impairments. Forgetting things can increase the complexity of their lives. They even have to face many challenges when living. Sometimes this can be a difficulty to their family and caretakers as well. As we focus on the patient's independency, the proposed solutions are directed towards that. We are considering the mild to moderate stages of the disease

and most of the affected persons are older. Therefore, their literacy and even vocabulary is poor.

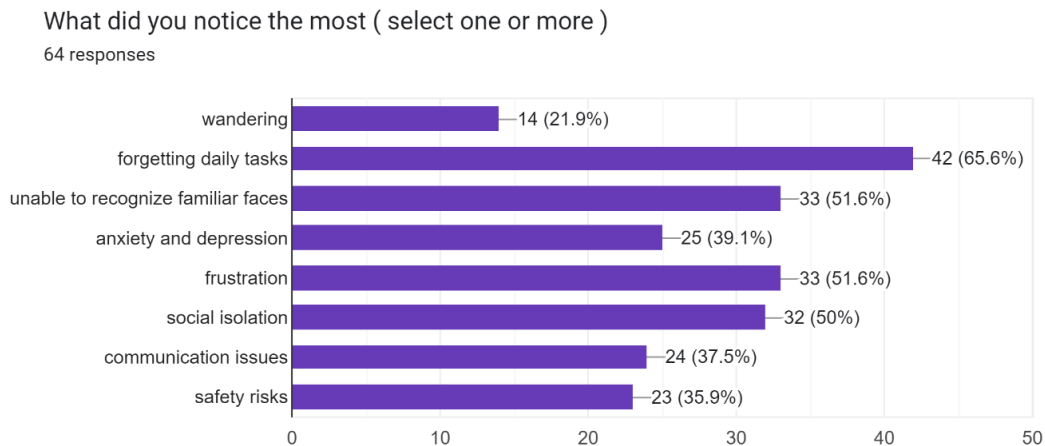


Figure 1.3. 1 survey results on noticing behavior

The above figure shows the responses for noticing the behavioral patterns of dementia patients by the audience.

Dementia patients may forget how to perform routine activities such as dressing, grooming, and cooking, which can make them reliant on others for assistance. They can keep a note regarding such details as well. Because later this can help them remember things. Dementia patients may struggle to remember people's names and faces, which can make social interactions difficult and lead to social isolation. This isolation also can be eradicated if they keep tracking these requirements. They may forget words or struggle to form coherent sentences, making communication difficult. By keeping a diary their literacy skills and then communication skills can also be improved. Forgetting things can be frustrating and stressful for dementia patients, leading to agitation and behavioral issues. Such instances can also be avoided if they practice keeping a personal journal with

them. Overall, forgetting things can have a significant impact on the daily life and well-being of dementia patients, and strategies to manage this symptom are an important part of their care plan.

The following diagram represents how the audience reacted to benefits of keeping a diary.

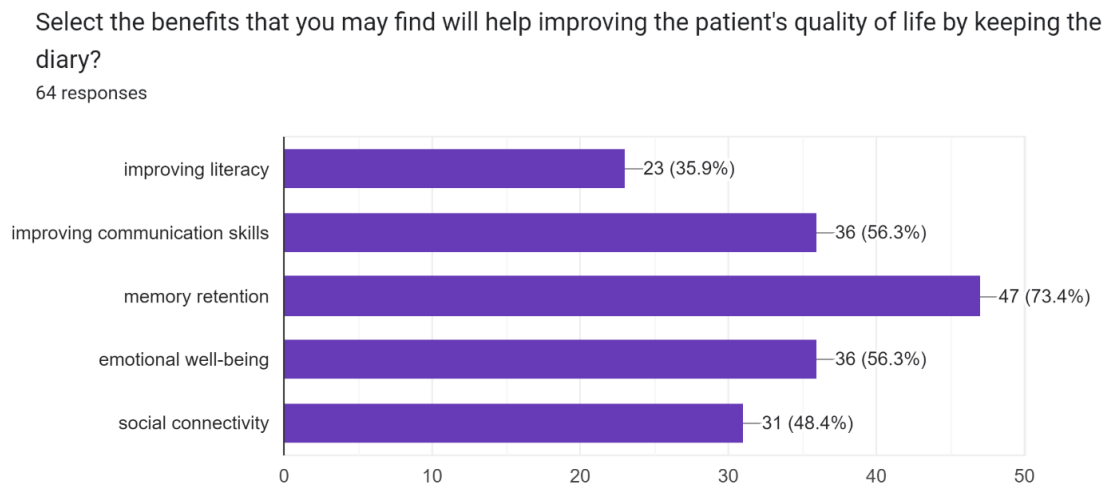


Figure 1.3. 2 survey results on benefits for quality of life

The results of the study indicate that factors which improve memory retention, communication skills, and emotional wellbeing are highly valued by participants as being beneficial for enhancing the lives of those with dementia. These findings suggest that these elements are crucial for the overall wellbeing of individuals with dementia.

Finding techniques to enhance memory function can significantly benefit someone with dementia's quality of life because memory retention is one of their main concerns. It is possible to increase people's capacity for communication and social interaction by giving them the tools and techniques necessary to remember information and recall significant experiences. Another crucial factor in raising the quality of life for those with dementia is

improving communication abilities. Communication difficulties that arise as the illness worsens might make people feel frustrated and alone. It is possible to enhance a person's capacity to connect with people and uphold social ties by giving them the tools necessary to speak more successfully, such as speech therapy or assistive technologies. Dementia sufferers must also take their emotional health into account. Anxiety, depression, and other emotional difficulties may accompany the illness and negatively affect the patient's general quality of life. It is possible to assist people in coping with these difficulties and preserving their sense of well-being by offering emotional support, such as therapy or support groups.

In general, the results of the survey demonstrate that attributes that improve memory retention, communication skills, and emotional wellbeing are considered valuable by the respondents as means to improve the quality of life of individuals with dementia. Focusing on these areas to aid individuals in preserving their cognitive abilities, communicating effectively, and maintaining emotional wellbeing can provide the assistance they require and ultimately enhance their overall quality of life.

2. RESEARCH OBJECTIVES

2.1. Main Objective

Designing a smart solution via an application to improve the quality of life and the independence of a Dementia patient is the main objective of the proposed whole system. Improving the independence and quality of life of dementia patients requires a holistic approach that addresses physical, emotional, and environmental factors. Working with healthcare professionals and caregivers can help develop an individualized plan that meets the unique needs of each patient. The proposed system basically covers most of the above-mentioned factors.

2.2. Specific Objectives

Improving the cognitive independence and wellbeing of dementia patients by motivating them to maintain a digital audio diary.

User's voice detection and speech recognition

- a proper mechanism should be implemented to detect the user's voice via the mobile phone. Implementing a robust mechanism for detecting the user's voice through their mobile phone is paramount to the success of this application. The ability to seamlessly capture and recognize the user's voice enables a natural and intuitive interaction with the system. By ensuring precise voice detection and speech recognition, the application not only enhances accessibility but also empowers users, particularly those with mobility or cognitive impairments. This feature fosters inclusivity and ensures that the technology can be effectively utilized by a diverse range of individuals, ultimately improving the overall user experience.

Converting speech to text

- user's speech should be converted into text in order to save them as text files to view them in future. The conversion of user speech into text is a

fundamental function that underpins the practicality and utility of the application. By transforming spoken words into written text, this technology provides users with a tangible record of their thoughts and experiences. These text files serve as valuable digital diaries, preserving personal memories and insights for future reference. This feature has far-reaching implications, particularly in healthcare and personal documentation, as it simplifies the process of recording and reviewing information. Moreover, it aligns with the broader trend of digitizing and organizing information in an increasingly digital world.

Text summarization

- It is possible to create a summary of the text that highlights the most significant information, providing a more concise version of the original text. The capability to create concise summaries of the transcribed text marks a significant advancement in information management and accessibility. Text summarization technology distills lengthy narratives into succinct, coherent, and informative summaries, accentuating the most salient details. This function not only saves users valuable time but also enhances comprehension by providing a snapshot of the essential information. In various contexts, such as educational content, news articles, or personal diaries, text summarization streamlines the consumption of information, making it more digestible and accessible. The ability to offer users a concise version of the original text significantly contributes to the efficiency and effectiveness of the application, ensuring its relevance in today's fast-paced world.

3. METHODOLOGY

3.1. Methodology

This research component is divided into two main aspects where one part covers the voice recognition and voice to text conversion while the other part includes text summarization mechanism. For the voice recognition and voice to text conversion react native voice library is used. The text summarization is implemented with fine tuning the hugging face BART model [6].

Voice recognition can be achieved by integrating the react-native-voice library. After setting up the project and installing the library, need to request permissions to access the device's microphone. Then, in the user interface where users can trigger voice recognition, a button can be implemented. Within the component, we can use the library's methods to start the recognition process, specifying the desired locale. Callback functions like onSpeechResults will provide the recognized speech, allowing to handle the results as needed. It's essential to implement error handling, stop recognition when it's no longer needed, and thoroughly test the feature on various devices [7].

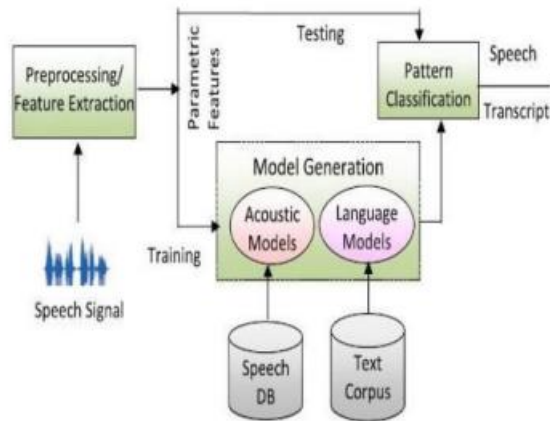


Figure 3.1. 1 structure of a basic voice recognition model

When converting voice to text, a separate button can be triggered, by taking voice

recordings as input. React-native-voice library can process the recorded audio and convert it into text. The recognized text can then be displayed or saved as needed.

Hugging Face's BART (Bidirectional and Auto-Regressive Transformers) model stands out as a formidable tool for text summarization tasks. Its unique prowess lies in its ability to effortlessly distill lengthy texts into concise and coherent summaries, making it a sought-after resource for a wide array of natural language processing applications. BART achieves this through a sophisticated fusion of bidirectional and autoregressive transformers. By comprehensively understanding the context and intricate relationships within a given text, BART captures the essence of the source material with remarkable precision. This capacity for nuanced comprehension allows BART to reconstruct the content in a more compact and digestible form, resulting in summaries that are both informative and succinct. Whether it's condensing extensive documents, distilling the core insights from news articles, or simplifying complex information for improved accessibility, BART's summarization capabilities have proven invaluable across diverse domains. Moreover, the flexibility to fine-tune BART on specific datasets or domains empowers developers and researchers to create highly effective, domain-specific summarization models, further enhancing its utility in extracting key insights and aiding decision-making processes [8].

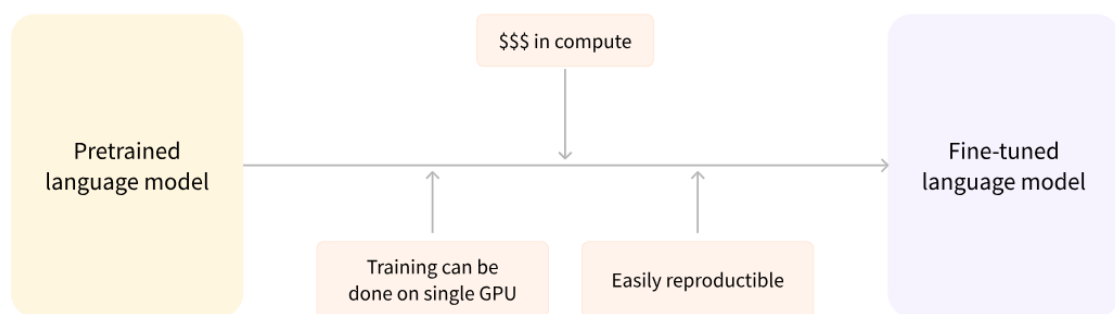


Figure 3.1. 2 finetuning BART model

This approach can be used to summarize the text content in the diary and make available for the caregivers to take a review about the diary records.

3.1.1. System Architecture

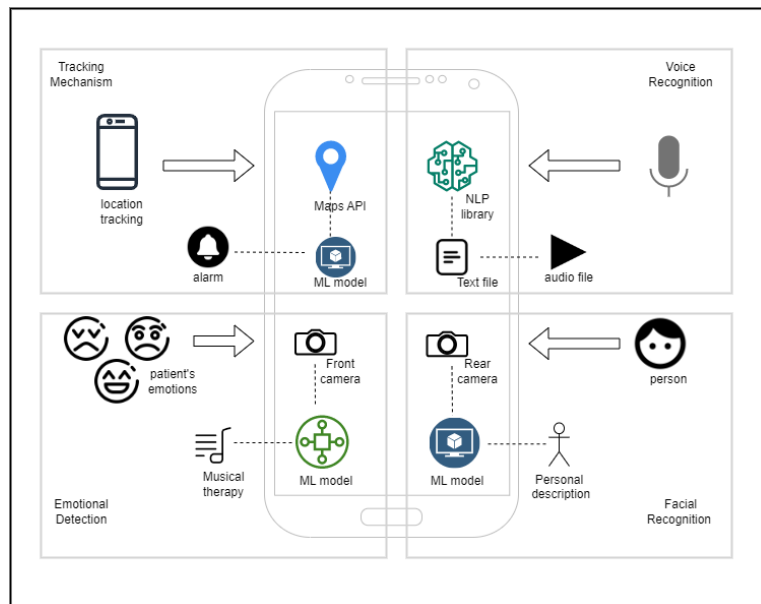


Figure 3.1. 3 overall system architecture diagram

The above figure illustrates how all the four components are integrated to the mobile application. Relevant technologies have been used to implement each and every functionality.

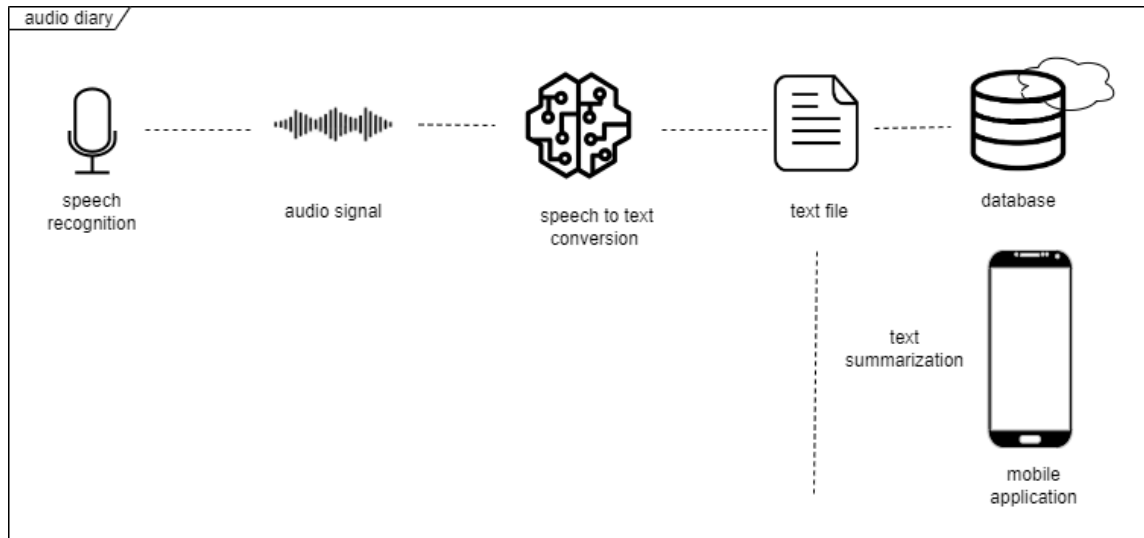


Figure 3.1. 4 audio diary component

The above diagram illustrates how the audio diary component is being implemented. User's voice is recorded and then it is converted into text format. Both the audio file and the text file are stored in the cloud database to access whenever necessary. The generated text file is used for the summarization purpose.

3.1.2. Data collection methods

The CNN/DailyMail dataset, a well-known and useful source for natural language processing tasks, is the main source of data collection for fine-tuning the BART model. This dataset is a great option for improving the model's summarizing abilities because it includes a wide range of news articles and the related human-generated summaries. This text corpus was painstakingly curated and preprocessed as part of the data gathering process to guarantee data quality and relevance. The original source articles and their corresponding abstractive summaries are maintained with special care. The CNN/DailyMail dataset, which has been painstakingly chosen, provides the basis for fine-

tuning the BART model and enabling it to succeed in abstractive summarization tasks by learning from the rich and diverse content [9].

3.1.3. Tools and Technologies

Tools

- VS code
 - To implement the mobile application
- Postman
 - To test the mobile application
- Google Colab
 - To finetune the BART model

Technologies

- React native
 - Used to implement mobile application
- Firebase
 - Used to implement the database
- FastAPI
 - To implement the backend API for the mobile application

Table 2: external tools

Description	Tools
Version Controlling	Gitlab
Team connectivity	Teams, WhatsApp

3.2. Commercialization aspects of the product

In our pursuit of commercializing our mobile application, which holds immense potential to benefit individuals worldwide, we recognize the need for a multifaceted approach that aligns with current global trends and user behaviors. Given that our application operates in the international language of English, its reach extends far beyond the borders of Sri Lanka, making it accessible and relevant to a global audience. To ensure swift and widespread adoption, we have strategically identified several key avenues for commercialization, with a primary focus on harnessing the immense power of social media platforms.

In today's digital landscape, social media stands out as a dynamic and influential force. With millions of users spending a substantial portion of their daily lives on platforms such as Facebook, WhatsApp, Instagram, and YouTube, leveraging these channels for advertising and promotion is not only prudent but essential. Through targeted and engaging adverts on these platforms, we can effectively introduce our application to a vast and diverse consumer base, transcending geographical boundaries.

Furthermore, we have recognized the importance of content providers in shaping trends and boosting user engagement. Platforms like YouTube, Twitch, and Trovo are home to a growing community of content creators with large followings. By selectively sponsoring and supporting these influencers, we can use their reach and influence to raise awareness about our system within their respective communities. This spontaneous recommendation

can help us create confidence and credibility for our application.

To broaden our reach, we intend to work closely with healthcare organizations such as hospitals and clinics. Within their particular communities, these institutions provide reliable sources of knowledge and care. We can design targeted awareness programs that appeal to both healthcare professionals and patients by collaborating with them. This strategy ensures that our application reaches people from all walks of life, regardless of financial status.

We recognize the lasting power of conventional media in addition to digital platforms. For example, leaflets can be a useful instrument for increasing public awareness of our product, particularly within rural communities. We also recognize the importance of radio and podcasts, which continue to have a loyal following. Sponsoring radio shows and podcasts that cater to our target audience can be a beneficial outlet for advertising our product and its benefits.

3.3. Project requirements

3.3.1. Functional requirements

- The system should be able to convert speech to text.
- The system must be compatible with the language support and vocabulary support.
- The system must be implemented considering the context awareness.
- The system must be compatible with the integration.
- The system should generate the summary analyzing the text generated.

3.3.2. Non-functional requirements

- Performance - the application needs to be optimized for mobile platforms that dementia patients frequently use. This entails making sure the application is snappy, launches quickly, and uses minimal data or energy.

- Scalability - The application should be able to handle increased traffic and usage when more dementia sufferers start using it without slowing down or crashing. This could entail making the application responsive on various mobile device types and making sure the backend infrastructure can support the added demand.
- Security - The program should be created with straightforward and efficient security features because dementia sufferers may have trouble understanding or remembering sophisticated security procedures. This may involve taking steps like data encryption, auto-logouts, and biometric authentication.
- Reliability - The application should be made to function consistently and dependably, even in challenging circumstances. This might include attributes like offline functionality, error handling, and automatic data backups.
- Maintainability - Even when new features are added or the application is modified for new mobile device kinds, the application should be simple to maintain and update. This could involve using modular components, comprehensive documentation, and well-structured code in the design of the application.

3.3.3. User requirements

- This mobile application must be installed to the user's smart phone.
- User should have basic knowledge in English language.
- User should have an understanding about how to use a simple mobile application.

3.4. Testing and Implementation

3.4.1. Implementation

The system implementation is done by focusing on the frontend and backend separately. As discussed previously, the development process includes the implementation of the

below functionalities to accomplish all the identified requirements.

- An android mobile application using React native as the frontend technology.
- Implementation of profile sections for both dementia patients and caregivers.
- Implementation of a voice recognition system alongside with voice to text conversion.
- Designing a text summarization model to summarize the content
- A mechanism to access daily diary records using a calendar.

The following methodology was used to develop the frontend part of the proposed application in order to deliver a seamless efficient user experience:

- A react native app was built as the front end with utilizing Expo Go as the runtime environment.
- All the user interfaces were designed and implemented once the React Native app was set up with the necessary configurations.
- Lastly, an API connection was made between the front end and the back end to enable the execution of machine-learning models.

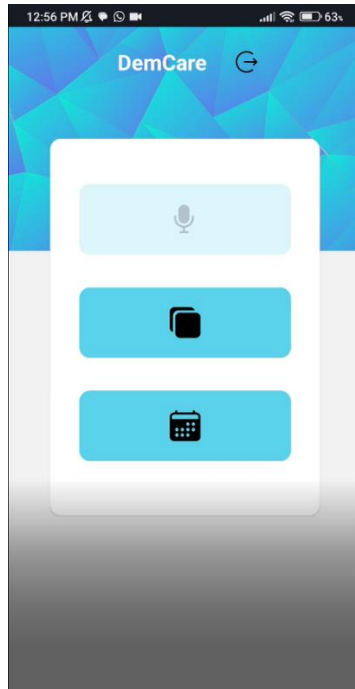


Figure 3.1. 5 UI of audio diary component

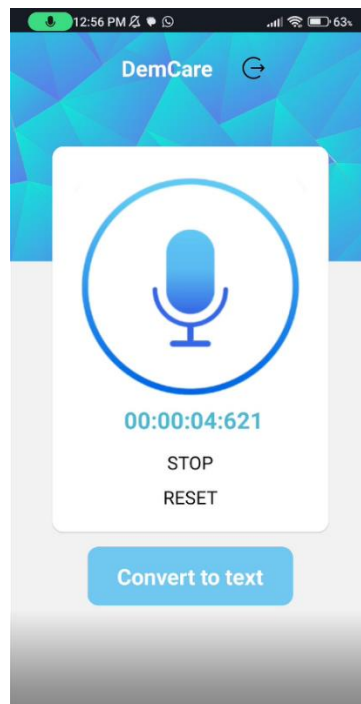


Figure 3.1. 6 UI of voice recorder

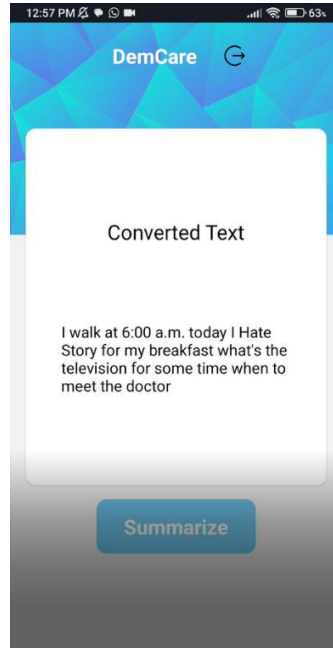


Figure 3.1. 7 UI of converted text

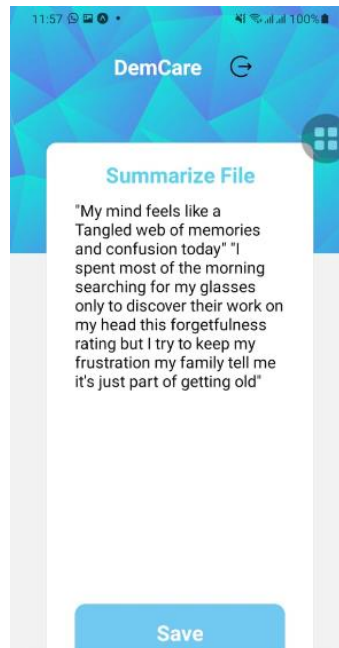


Figure 3.1. 8 UI of summarized text

Back end implementation for this research component includes fine tuning the BART model and implementing the text summarization mechanism.

Several crucial steps must be taken in order to perfect the BART model from Hugging Face for text summary. The pre-trained BART model and tokenizer must be loaded first. To train the model, one must then obtain a sufficient dataset, frequently in a structured manner. The dataset typically consists of text data pairs with the source text (for example, articles) and destination text (for example, summaries) being the same.

Data preprocessing follows, including tasks such as tokenization and formatting the data into input-target pairs. This ensures that the model can understand and learn to generate summaries effectively. Subsequently, the dataset is split into training and validation sets to evaluate the model's performance during training.

The batch size, number of training epochs, and assessment procedures are only a few examples of the training parameters and arguments that must be specified. It is common practice to prepare the data for training using a data collator tailored to sequence-to-sequence tasks. This collator handles operations like padding and token-to-number conversion.

Throughout training, model checkpoints can be saved to ensure that the fine-tuning process can be resumed or evaluated later. Additionally, evaluation metrics are used to assess the model's performance on the validation set, helping to monitor progress and identify potential overfitting.

The model can be stored for future use after the fine-tuning procedure is finished. It may be used to create summaries for fresh text input, making it a useful tool for information extraction and content summarization. Therefore, fine-tuning the BART model is a structured method of modifying a potent pre-trained model for the particular purpose of text summarization.

```

# Import necessary libraries
import os
import torch
!pip install transformers
from transformers import BartTokenizer, BartForConditionalGeneration, BartConfig
from torch.utils.data import Dataset, DataLoader
from sklearn.model_selection import train_test_split
from tqdm import tqdm
import pandas as pd

```

Figure 3.1. 9 code snippet of importing libraries into google colab

```

[ ] # Load and preprocess the dataset
df_train = pd.read_csv(train_file)
df_valid = pd.read_csv(valid_file)
df_train
df_valid

```

	Unnamed: 0	article	highlights	id
0	0	It's official: U.S. President Barack Obama wan...	Syrian official: Obama climbed to the top of t...	0001d1afc246a7964130f43ae940af6bc6c57f01
1	1	(CNN) -- Usain Bolt rounded off the world cham...	Usain Bolt wins third gold of world championsh...	0002095e55fcbd3a2f366d9bf92a95433dc305ef
2	2	Kansas City, Missouri (CNN) -- The General Ser...	The employee in agency's Kansas City office is...	00027e965c8264c35cc1bc55556db388da82b07f
3	3	Los Angeles (CNN) -- A medical doctor in Vanco...	NEW: A Canadian doctor says she was part of a ...	0002c17436637c4fe1837c935c04de47adb18e9a
4	4	(CNN) -- Police arrested another teen Thursday...	Another arrest made in gang rape outside Calif...	0003ad6ef0c37534f80b55b4235108024b407f0b
...
9995	95	President Barack Obama signed an executive ord...	Executive order bars contractors covers LGBT e...	004e6e935ea530b0992a89fd1307f7f41f4a234d
9996	96	Editor's note: This is an excerpt from the Feb...	In rural Africa, there is love for soccer but ...	004f0f8c694c4b546b29565a8993a555537ff561
9997	97	(CNN) -- The International Olympic Committee h...	It's the first time a ban of a national commit...	004fc12e7cd2505a013d96e816afae3f3ce5015d
9998	98	(Mother Nature Network) -- Mother's Day poems ...	Poets have long written about their mothers or...	00504275ede73591d94a6c1f994fd4856610421c
9999	99	LONDON, England (CNN) -- When Danish auteur La...	Pornographic sex and visceral violence in "Ant...	00512126d65bf2a36801e4ef37f28c86c29deb28

Figure 3.1. 10 loading dataset in google colab

```

[ ] # Split data into train and validation sets
train_texts = df_train["article"].tolist()
train_summaries = df_train["highlights"].tolist()
valid_texts = df_valid["article"].tolist()
valid_summaries = df_valid["highlights"].tolist()

```

Figure 3.1. 11 splitting data

```

[ ] # Tokenize the data
tokenizer = BartTokenizer.from_pretrained("facebook/bart-large-cnn")
train_encodings = tokenizer(train_texts, truncation=True, padding=True, max_length=1024, return_tensors="pt", add_special_tokens=True)
train_labels = tokenizer(train_summaries, truncation=True, padding=True, max_length=150, return_tensors="pt", add_special_tokens=True)
valid_encodings = tokenizer(valid_texts, truncation=True, padding=True, max_length=1024, return_tensors="pt", add_special_tokens=True)
valid_labels = tokenizer(valid_summaries, truncation=True, padding=True, max_length=150, return_tensors="pt", add_special_tokens=True)

```

Figure 3.1. 12 tokenizing data

```
[ ] # Create a custom PyTorch dataset
class SummarizationDataset(Dataset):
    def __init__(self, encodings, labels):
        self.encodings = encodings
        self.labels = labels

    def __len__(self):
        return len(self.encodings["input_ids"])

    def __getitem__(self, idx):
        item = {key: val[idx] for key, val in self.encodings.items()}
        item["labels"] = self.labels["input_ids"][idx] # Use "labels" key for labels
        return item

train_dataset = SummarizationDataset(train_encodings, train_labels)
valid_dataset = SummarizationDataset(valid_encodings, valid_labels)
```

Figure 3.1. 13 creating custom dataset

```
[ ] # Initialize the model and training parameters
model = BartForConditionalGeneration.from_pretrained("facebook/bart-large-cnn")
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
model.to(device)
model.train()
```

Figure 3.1. 14 initializing the model

```
[ ] # Define training parameters
train_batch_size = 4
valid_batch_size = 4
num_train_epochs = 1
learning_rate = 3e-5
```

Figure 3.1. 15 defining training parameters

```
[ ] # Training loop
    for epoch in range(num_train_epochs):
        model.train()
        train_loss = 0.0

        for batch in tqdm(train_loader, desc=f"Epoch {epoch}"):
            optimizer.zero_grad()
            input_ids = batch["input_ids"].to(device)
            attention_mask = batch["attention_mask"].to(device)
            labels = batch["labels"].to(device)
            # input_ids = batch["input_ids"]
            # attention_mask = batch["attention_mask"]
            # labels = batch["labels"]

            outputs = model(input_ids, attention_mask=attention_mask, labels=labels)
            loss = outputs.loss
            loss.backward()
            optimizer.step()
            train_loss += loss.item()

        # Print training loss for this epoch
        print(f"Epoch {epoch}: Train Loss: {train_loss / len(train_loader)}")
```

Figure 3.1. 16 training loop with epoches

```
[ ] # Save the fine-tuned model
    output_dir = "fine_tuned_bart"
    os.makedirs(output_dir, exist_ok=True)
    model.save_pretrained(output_dir)
    tokenizer.save_pretrained(output_dir)
```

Figure 3.1. 17 saving the model

After the model was saved a docker container was must be created to encapsulate the model and its dependencies. This containerization ensures portability and scalability. Once the Docker image is built, it can be hosted on a server or cloud platform, making it accessible over the internet.

To integrate the model into the mobile app, need to develop an API endpoint within the Docker container that accepts text input and responds with generated summaries. The

mobile app can then send requests to this API to obtain summarization services.

```
services > JS summarize_service.jsx > ...  
/3  
74 export const getSummaries = async (date) => {  
75   let summaries = [];  
76   const db = getFirestore(db);  
77   const q = query(  
78     collection(db, "summaries"),  
79     where("summered_by", "==", auth.currentUser.uid),  
80     where("date", "==", date)  
81   );  
82   const querySnapshot = await getDocs(q);  
83   querySnapshot.forEach((doc) => {  
84     summaries.push({ id: doc.id, ...doc.data() });  
85   });  
86   return summaries;  
87 };  
88  
89 export const deleteSummary = async (id) => {  
90   const db = getFirestore(db);  
91   await deleteDoc(doc(db, "summaries", id));  
92 };  
93  
94 export const addSummary = async (data) => {  
95   try {  
96     const date = formatDate(new Date());  
97     const d = {  
98       summered_by: auth.currentUser.uid,  
99       summary: data,  
100      date: date,  
101    };  
};
```

Figure 3.1. 18 code snippet of summarize service

3.4.2. Testing

The testing stage of the development lifecycle of any mobile application is crucial. It entails a methodical and thorough assessment of the app's performance, security, usability, and functionality on a range of mobile platforms and devices. Professional testers and quality assurance teams carefully examine the functionality and user interface of the app during this process to find and fix any bugs, flaws, or inconsistencies. Through testing for compatibility, the software is ensured to work flawlessly across a range of operating systems, screen sizes, and device settings, ensuring a great user experience for a large audience. While security testing protects sensitive user data and the integrity of the app overall, performance testing evaluates the app's responsiveness and speed. Real users participate in user acceptability testing, providing comments on the usability and general happiness of the app.

Some of the test cases used to test the product are included below, along with screenshots.

Table 3: test cases

Test Case #	Test case	Result
001	Asking permissions to access microphone	Pass
002	All the buttons and widgets are visible	Pass
003	Navigate for pages through buttons	Pass
004	Voice recording successfully saved	Pass
005	Text conversion happened successfully	Pass
006	Text summarization happened successfully	Pass
007	Accessing daily records via the calendar	Pass
008	Care giver accessible for summarized texts	Pass

009	Saving the audio file	Pass
010	Saving the converted text file	Pass
011	Saving the summarized text file	Pass

Above table shows the test cases done for audio diary component. Also, this application was tested by using two end users and below table shows the results of it. For that we contacted two people with moderate dementia and a one who are capable of speaking English. Those people are respectively named in the table as User 2 and User 1.

Table 4: test cases for end users

Test Case #	Test case	User 1	User 2
001	Open the mobile application without any error	Opened the application without any issue	Opened the application without any issue
002	Recording started after touching record button	Able to record the voice.	Able to record the voice.
003	Navigate for pages through buttons	Navigated through all the pages	Navigated through all the pages
004	Text conversion started after touching convert to text button	Able to view the text	Able to view the text
005	Text summarization happened	Text summarized to a small paragraph	Text summarized to a small paragraph

Finally, to complete the testing process we tested out application with different OS versions with different kind of android devices. The test cases for that are shown below in the table.

Table 5: test cases for different devices

Test Case #	Device	OS	Version issues	Issues with the interfaces
001	Xiaomi X3Pro Poco phone	Android 13	No issues	No issues
002	Redmi 9	Android 11	No issues	No issues
003	Samsung galaxy grand prime	Android 5	No issues	No issues

4. RESULTS AND DISCUSSION

4.1. Results

A significant step forward in improving the quality of life for people with moderate dementia has been made possible by the successful voice recognition and voice-to-text conversion testing results within a mobile application. The program has successfully captured the ideas and recollections of users who may struggle with cognitive impairments through careful testing of its capacity to faithfully translate spoken words into text.

This accomplishment creates new opportunities for dementia patients to easily record their thoughts, feelings, and observations from day to day, encouraging a sense of independence and self-expression. As a result of the app's effectiveness with speech recognition, users can engage with it naturally, which lessens annoyance and makes it more approachable for people with different levels of technological expertise. Overall, these favorable outcomes have the potential to improve not just the usability of the mobile app but also the wellbeing and cognitive ability of dementia patients.

The positive results achieved through fine-tuning the BART model for text summarization have been nothing short of transformative for natural language processing tasks. By fine-tuning on diverse datasets and domain-specific corpora, BART has exhibited exceptional proficiency in abstractive summarization. Its ability to generate coherent, concise, and contextually relevant summaries from lengthy texts has made it an indispensable tool across various applications. The model excels in distilling information from complex documents, making it invaluable in news summarization, academic research, and content curation. Furthermore, BART's adaptability to different languages and domains enhances its versatility, making it an ideal choice for multilingual summarization tasks. These positive outcomes have not only streamlined content summarization processes but have also significantly improved the accessibility of information, making it more digestible and

accessible to a wider audience. In essence, fine-tuning the BART model for text summarization has ushered in a new era of efficient and effective information extraction, benefiting industries, researchers, and consumers alike.

BART can distill lengthy diary entries into concise and coherent summaries. This is particularly useful when people want to revisit past entries quickly or when caregivers or healthcare professionals need a quick overview of a patient's daily experiences. For individuals with cognitive impairments, like dementia patients, BART's summarization can serve as a memory aid. It condenses complex thoughts and emotions from diary entries, helping users recall significant events and emotions they might otherwise struggle to remember. Manually reviewing or transcribing lengthy diary notes can be time-consuming. BART automates the summarization process, saving both time and effort for users and caregivers. BART's summarization can make diary entries more accessible to a wider audience, including those who may find it challenging to read lengthy text. This is particularly important in healthcare settings or when sharing diary notes with family members and caregivers.

4.2. Research Findings

Dementia, particularly in its moderate stages, poses significant challenges for individuals and caregivers alike. In pursuit of innovative solutions to enhance the lives of those affected, extensive research has been conducted into the development of an Audio Diary with Text Conversion and Summarization application tailored specifically for moderate dementia patients. Here are some findings gathered.

- **Enhanced memory recall** - One of the most remarkable findings from this research indicates that this component plays a pivotal role in enhancing memory recall among moderate dementia patients. By enabling users to effortlessly record their thoughts and experiences in spoken form, the application not only preserves their

precious memories but also converts them into written text. This transformative feature empowers patients to revisit and reflect upon their past experiences, fostering a sense of continuity and self-awareness.

- Streamlined communication – this component has proven to be a valuable tool in facilitating communication between dementia patients, caregivers, and healthcare professionals. The text conversion and summarization capabilities enable users to articulate their thoughts more coherently, reducing frustration and miscommunication. Caregivers and healthcare providers, in turn, gain insights into the patient's daily experiences, allowing for more effective care planning and emotional support.
- Improved emotional wellbeing - Our research has demonstrated a significant improvement in the emotional well-being of moderate dementia patients who use this mobile app. The ability to express their feelings and thoughts in a diary format fosters emotional release and self-expression, reducing anxiety and depression often associated with dementia. The summarized text entries provide patients with a digestible overview of their experiences, helping them process and manage their emotions more effectively.
- Caregiver relief - this has also had a profound impact on caregivers. By automating the summarization of diary entries, it relieves caregivers of the time-consuming task of reviewing and transcribing lengthy notes. This not only reduces caregiver stress but also allows them to allocate more quality time to their loved ones.

4.3. Discussion

One pivotal aspect of our research paper focuses on the discussion of how the Audio Diary

with Text Conversion and Summarization addresses the profound challenges of communication and memory preservation in the context of moderate dementia patients. By employing the React Native Voice Library, this innovative solution empowers these individuals to express themselves with ease and clarity, despite the linguistic and cognitive difficulties often associated with dementia. The voice-to-text conversion feature becomes a bridge, allowing patients to articulate their thoughts and emotions in their own voice, preserving not just the words but also the authenticity of their experiences.

Furthermore, the integration of the BART model plays a crucial role in the memory preservation process. It offers the capability to transform spoken recollections into written text, creating a digital archive of personal narratives that can be revisited at any time. This has a profound impact on the patient's emotional well-being, fostering a sense of continuity and self-identity as they are able to recall and reflect upon their past experiences, even as memory challenges persist.

By offering an accessible and intuitive means of expression and memory preservation, this component goes beyond being a mere technological tool; it becomes a source of empowerment for moderate dementia patients. It enables them to communicate their feelings, experiences, and preferences, thereby enhancing their quality of life and enabling them to maintain a sense of independence. The technology serves as a testament to the potential of merging cutting-edge solutions like the React Native Voice Library and the BART model with compassionate care, ultimately improving the lives of those navigating the complexities of dementia.

4.4. Summary of student contribution

Student: Jayasinghe J.M.S.U. – IT20034740

Research component: Improving the cognitive independence and wellbeing of dementia patients by motivating them to maintain a digital audio diary

Task: This component is aligned with to develop a system to recognize voice and convert it into text and then summarize the content.

Tasks completed:

- Developed the mobile application
- Implemented the backend with fastapi to get the text summarization services by the application
- Developed text summarization models.
- Implemented proper mechanisms to recognize voice and convert it into text
- Developed all the user interfaces related to audio diary component.

5. CONCLUSION

In conclusion, the development and implementation of the Audio Diary with Text Conversion and Summarization within the Dementia application, leveraging the React Native Voice Library and the BART model, mark a significant milestone in the realm of dementia care. Our research paper has shed light on the transformative potential of this technology to enhance the lives of moderate dementia patients and their caregivers. This not only addresses the pressing issues of communication and memory preservation but also empowers patients to maintain their independence and self-identity. By allowing individuals to express themselves in their own voice and converting their spoken memories into written text, the application fosters a profound sense of continuity and self-awareness. Moreover, the summarization capability provided by the BART model adds an invaluable dimension to the application. It condenses lengthy diary entries into concise and coherent summaries, offering users a digestible overview of their experiences and emotions. This not only eases the cognitive burden on patients but also provides caregivers and healthcare professionals with valuable insights to deliver more personalized and

empathetic care. As our research has demonstrated, Demcare represents a harmonious fusion of cutting-edge technology and compassionate care. It strikes a delicate balance between innovation and the preservation of the human touch in dementia care, ultimately improving the quality of life for those living with moderate dementia. While challenges and ethical considerations must be addressed, the potential for this technology to revolutionize dementia care is undeniable. Looking ahead, Demcare holds promise for further advancements and refinements. Future research can explore the integration of additional features, improved user interfaces, and enhanced data security to ensure the continued success and widespread adoption of this valuable tool. With continued collaboration between researchers, caregivers, and technology developers, Demcare paves the way for a brighter, more empowered future for moderate dementia patients and their caregivers, embodying the potential for technology to make a meaningful impact on the lives of those in need.

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APPENDICES



Appendix A: Online Survey

Survey on Dementia and experimental research

Dear Respondent,

I'm a Final year student from the department of computer science and software engineering, faculty of computing , SLIIT

I'm researching about dementia patients and their caretakers to identify patients' experiences in day to day life. This survey is conducted to gather some data required to proceed with the research.

 **shainiuj@gmail.com** (not shared) [Switch account](#) 

* Required

Have you ever heard of dementia *

☐ yes

☐ no

Have you ever seen their behavioral patterns (even from a documentary or a movie / tv series) *

☐ yes

☐ no

What did you notice the most (select one or more) *

- ☐ wandering
- ☐ forgetting daily tasks
- ☐ unable to recognize familiar faces
- ☐ anxiety and depression
- ☐ frustration
- ☐ social isolation
- ☐ communication issues
- ☐ safety risks

Do you know any person who is affected with dementia? *

- ☐ yes
- ☐ no

If yes, what is the relationship with the patient?

- ☐ family member
- ☐ friend

☐ neighbor

☐ other

That patient's age

☐ 1-20

☐ 20-30

☐ 30-40

☐ 40-50

☐ 50-60

☐ 60-80

☐ 80-100

Patient's gender

☐ male

☐ female

Do you keep a personal journal as a habit? *

☐ yes

☐ no

Do you think a personal journal would help dementia patients to stabilize their memory? *

☐ yes

☐ no

☐ may be

What kind of a diary will you recommend ? *

☐ written diary

☐ digital written diary

☐ audio diary app

Select the options that you may find beneficial for a dementia patient in an audio diary *

- ☐ easy access
- ☐ easy to handle
- ☐ saving previous audios
- ☐ speech recognition
- ☐ speech to text conversion
- ☐ named entity recognition
- ☐ speech summarization

What other features do you think that should be included in the app ?

Your answer

Select the benefits that you may find will help improving the patient's quality of life by keeping the diary? *

- ☐ improving literacy
- ☐ improving communication skills
- ☐ memory retention

☐ social connectivity

Have you ever heard of audio diaries implemented specifically for dementia patients? *

☐ yes

☐ no

Have you ever interacted with an audio diary application ? *

☐ yes

☐ no

Do you think those existing features in that app could help dementia patients too? *

☐ Yes

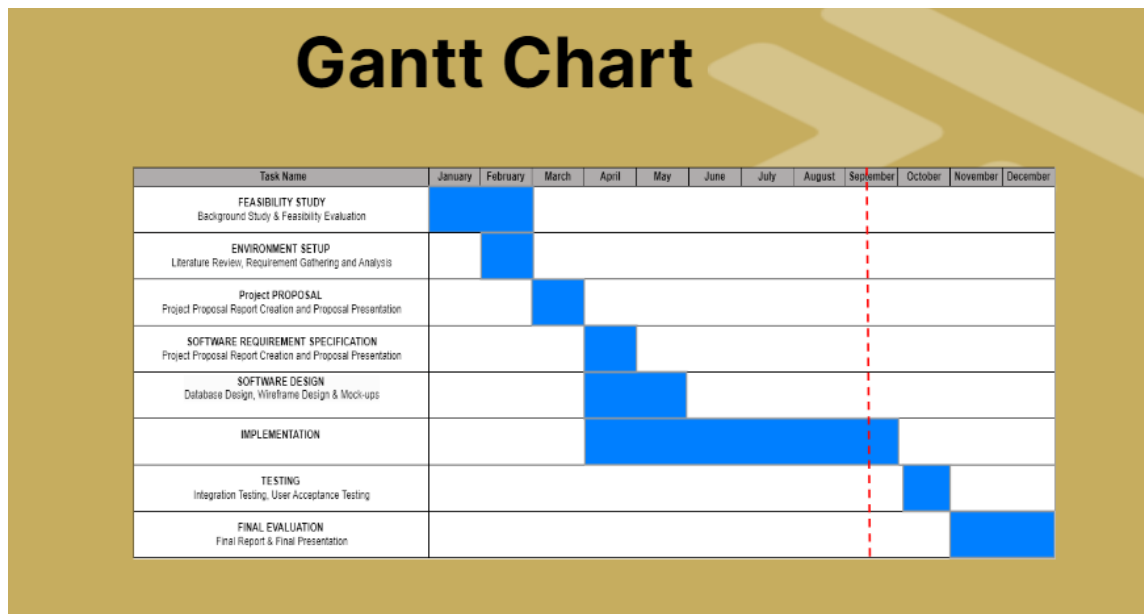
☐ No

☐ Maybe

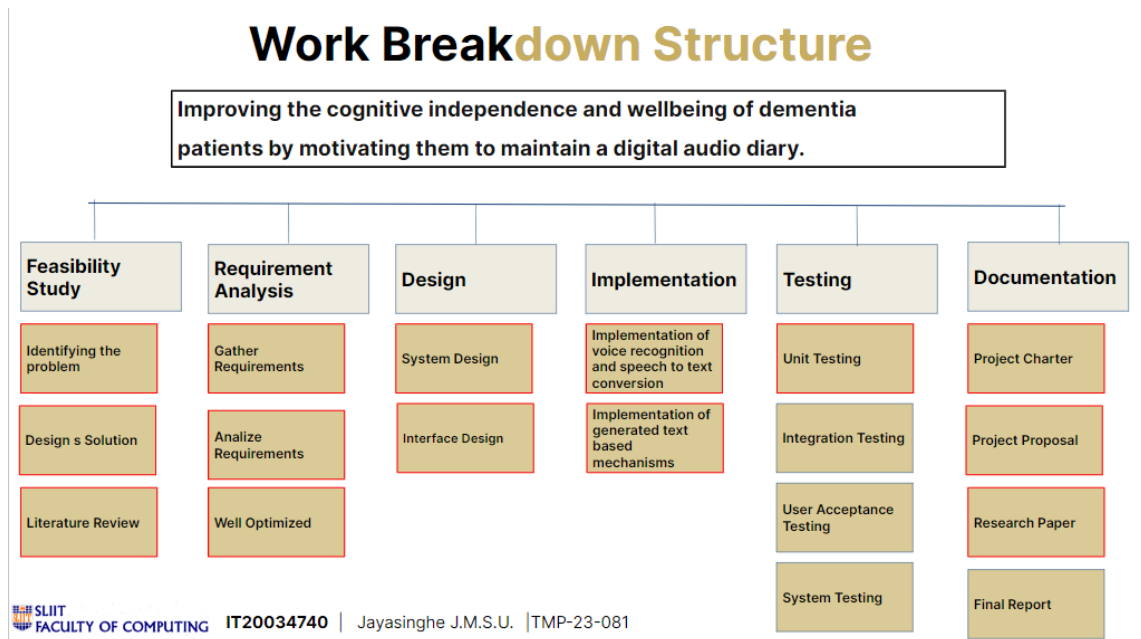
Submit

Clear form

Appendix B: Gantt chart



Appendix C: Work Breakdown Structure



Appendix D: Plagiarism report

final report it20034740			
ORIGINALITY REPORT			
7%	5%	2%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS
PRIMARY SOURCES			
1	Submitted to Sri Lanka Institute of Information Technology Student Paper	3%	
2	gitlab.sliit.lk Internet Source	1%	
3	Bartlett, R.. "Modifying the Diary Interview Method to Research the Lives of People With Dementia", Qualitative Health Research, 2012. Publication	1%	
4	www.coursehero.com Internet Source	<1%	
5	upcommons.upc.edu Internet Source	<1%	
6	Submitted to University of Sheffield Student Paper	<1%	
7	publications.aberdeenshire.gov.uk Internet Source	<1%	